SCREENING-LEVEL CALCULATION OF RISK TO EAGLE AND HERON FROM DDT, PCBS, AND MERCURY

This memo presents a screening-level assessment of potential risk to eagle and heron from DDT, PCBs, and mercury. An estimate of the exposure dose of each COPC is made and compared to an appropriate, conservative TRV. Conservative assumptions were used throughout this assessment to intentionally overestimate potential exposure and effects for the purpose of deciding whether additional detailed risk evaluation is justified.

EXPOSURE DOSE CALCULATION

The exposure dose estimates were calculated using the following equation:

$$\text{Exposure Dose} = \frac{\text{DFC} \times C_{\text{food}} \times \text{SUF}}{\text{BW}}$$

where:

Exposure Dose = COPCs ingested per day via food and sediment (mg COPC/kg body weight/day)

DFC = daily food consumption rate (kg food/day dw)
C_{food} = concentration in prey items plus sediment (mg COPC/kg food and sediment dw)
SUF = site use factor (unitless)
BW = wildlife species body weight (kg)

The calculated concentrations in prey items plus sediment (C_{food}) for each COPC/ROC pair are shown in Table 1. The highest measured concentration of the COPC in any whole body fish sample was used. Mercury was only analyzed in shiner perch or English sole, and DDT was only measured in juvenile chinook salmon. PCBs were measured in all three types of fish. The maximum measured concentrations of COPCs in sediment were used in calculating C_{food}.

Table 2 shows the values used in the exposure calculation, along with the calculated exposure dose.

Table 1. Concentrations of COPCs in food of heron and eagle

	Maximum Concentration in Prey/Sediment (mg/kg dw)		Fraction in Diet		C_{food} (mg/kg dw)
	Fish	Sediment	fish	Sediment	
Total DDTs	0.144[a]	2.88	0.98	0.02	0.199
Total PCBs	2.46[b]	222.6	0.98	0.02	13.5
Mercury	0.352[c]	4.6	0.98	0.02	0.437

a DDTs were only analyzed in chinook

b highest concentration was measured in English sole

c highest concentration was measured in shiner perch

Table 2. Calculation of exposure dose for each COPC

Chemical	DFC (kg/day dw)	C_{food} (mg/kg dw)	SUF	Female BW (kg)	Exposure Dose (mg/kg bw/day)
Great blue heron					
Total DDTs	0.13	0.199	1	4.68	0.0117
Total PCBs	0.13	13.5	1	4.68	0.797
Mercury	0.13	0.437	1	4.68	0.0258
Bald eagle					
Total DDTs	0.14	0.199	1	5.24	0.0053
Total PCBs	0.14	13.5	1	5.24	0.360
Mercury	0.14	0.437	1	5.24	0.0117

TRV Derivation

Because this is a screening-level calculation, the lowest TRVs identified in a laboratory study were chosen for total DDT, total PCBs, and mercury.

Total DDT

For total DDTs, the NOAEL and LOAEL were chosen from a laboratory study exposing American kestrels to DDE in the laboratory (Lincer 1975). Dietary doses to kestrels were at the following concentrations: control, 0.3, 3.0, 6.0 or 10 mg/kg. Thickness of eggshells from kestrels dosed at 3.0 mg/kg and higher were significantly lower than the controls. This was the lowest avian effect concentration found for DDT or its metabolites from database searches (including Cal/EPA database, ECOTOX, and BIOSIS) and other general searches in the scientific literature.

Assuming a body weight of 114 kg (average of measurements in several field studies compiled by California EPA 2002) and a food ingestion rate of 10.6 g/day (calculated using body weight regression equation for non-passerine birds in Nagy 1987), the NOAEL and LOAEL are 0.028 and 0.28 mg/kg bw/day, respectively.

.028
.28

Total PCBs

The LOAEL for total PCBs was derived from a study with ring-necked pheasants dosed with Aroclor 1254 (Dahlgren et al. 1972). Two treatment groups of birds were given capsules containing 12.5 mg PCBs or 50 mg PCBs each week for 16 weeks. In this study, hatchability of eggs was significantly reduced in the two treatment groups when compared to the control group. Assuming a body weight of 1 kg (Sample 1996), the LOAEL is 1.8 mg/kg/day. There was no lower bound measurement of the effect to determine a NOAEL.

Another study using screech owls found no effect on reproduction at 0.41 mg/kg bw/day, although this was the only dose applied, so it is uncertain how sensitive screech owls might be to PCBs (McLane and Hughes 1980). No other studies were found that had NOAELs lower than the LOAEL for ring-necked pheasants. Two studies with mallard resulted in higher reproductive NOAELs of 3.9 and 7 mg/kg bw/day (Risebrough and Anderson 1975; Custer and Heinz 1980), indicating that mallard is less sensitive to PCBs than ring-necked pheasant.

Mercury

The NOAEL for mercury is from a three-generation study with mallards (Heinz 1979). Methylmercury dicyandiamide was fed to adult mallards in their diet at a concentration of 0.5 mg/kg, and three generations of ducks were observed for reproductive effects. During all three generations, ducks fed mercury laid fewer sound eggs than did the controls, although the differences were statistically significant only in the third generation and combined data for all generations. During the second generation and for the combined data for all generations, ducks in the mercury treatment produced significantly fewer ducklings than did the controls. In addition, the shells of eggs laid by ducks fed mercury were significantly thinner than the shells of those laid by controls during the third generation and for the combined data of all generations.

Using the food consumption rate of 156 g/kg bw in treated birds, as measured in the study, and a body weight of 1 kg (Heinz et al. 1989, as cited in Sample et al. 1996), the LOAEL is 0.078 mg/kg bw/day. There was no lower bound measurement of this effect to determine a NOAEL, and no other dietary bird studies using methylmercury were found that contained no-effect levels.

HQ CALCULATION

The calculated hazard quotients are shown in Table 3. For total DDTs, the NOAEL and LOAEL HQs are less than one for both heron and eagle, indicating an acceptably low risk level for either species from total DDTs.

For PCBs and mercury, the LOAEL HQs for both species are less than one. NOAEL HQs could not be calculated for heron or eagle because NOAEL concentrations were not available.

Table 3. Calculation of hazard quotient for each ROC/COPC pair

Chemical	Exposure dose (mg/kg bw/day)	NOAEL (mg/kg bw/day)	LOAEL (mg/kg bw/day)	NOAEL HQ	LOAEL HQ
Great blue heron					
Total DDTs	0.0117	0.028	0.28	0.42	0.042
Total PCBs	0.797	NA	1.8	NA	0.44
Mercury	0.0258	NA	0.078	NA	0.33
Bald eagle					
Total DDTs	0.0053	0.028	0.28	0.19	0.019
Total PCBs	0.360	NA	1.8	NA	0.20
Mercury	0.0117	NA	0.078	NA	0.15

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